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HERBICIDES USED FOR CONTROL OF LESSER VEGETATION DAMAGE YOUNG LODGEPOLE PINE

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ABSTRACT

Herbicides used to kill understory vegetation caused mortality and reduced height growth of young leave-trees in a lodgepole pine spacing study designed to test the effect of removing competing vegetation. Both mortality and height growth reduction occurred during the first 2 years following herbicide treatment, apparently the result of too much herbicide being applied too early in the growing season. Growth processes did not appear to be permanently affected.

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KEYWORDS: herbicide effects, tree damage, lodgepole pine (*Pinus contorta* Dougl.), vegetation control

In 1965-1966, a study was installed on the Lewis and Clark National Forest in central Montana to provide information on lodgepole pine tree growth and stand development under different initial spacings. Another objective of the study was to determine the effect of the presence and absence of understory vegetation on the growth and development of the young trees at the various spacings.

Two replications of five square spacings--6, 9, 12, 15, and 18 feet--were installed in a random block design. To test the influence of competing vegetation, one-half of each spacing plot was sprayed with herbicides to kill the understory species, and the other half left unsprayed. The herbicides, intended to kill only the understory vegetation, caused unexpected tree mortality and reduced height increment of trees on the sprayed areas. This Note describes the study, herbicide application, the extent of damage, and suggests methods for minimizing herbicide damage in similar situations.

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BACKGROUND

Plots were established in an 8- to 10-year-old natural stand growing in an 18-acre clearcut. Lodgepole pine site index (at 100 years) was estimated at 55 feet, from measurements taken in the surrounding mature stand. The soils (described by Herbert Holdorf, USDA Forest Service, Soils Scientist, Lewis and Clark National Forest) are deep, light colored, formed in stony loam or heavy sandy loam material weathered from the underlying granitic bedrock, medium acid in reaction, take in water readily, are well drained, and contain no restrictions to root development. The forest vegetation is classified as an *Abies lasiocarpa/Vaccinium scoparium* habitat type.[2] Species in the understory were grouse whortleberry (*Vaccinium scoparium*), lupine (*Lupinus* spp.), and elk sedge (*Carex geyeri*). The area is essentially flat and located at 6,400 feet elevation.

Thinning was done in August 1965; slash was allowed to cure and compact until the following August, when the herbicides were applied during the period August 9-12. No rainfall was recorded in the few days before, during, and after the herbicide application.

The spray mixture contained 5 pounds active ingredient (ai) sodium salt of dalapon (2,2-dichloropropionic acid), 4.5 pounds acid equivalent (ae) low volatile propylene glycol butyl ether (PGBE) esters of 2,4-D (2,4-dichlorophenoxyacetic acid), and 4.5 pounds ae low volatile PGBE esters of 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) per 100 gallons. The chemicals were mixed in water.

Herbicides were applied with a 3-foot-wide, hand-held spray boom and a portable power sprayer having output capacity of 3 gallons per minute at 60 lb. pressure per square inch. Spray was applied to the understory vegetation until it dripped. The spray was carefully directed downward and away from the foliage of leave-trees. Despite this precaution, evidence of damage to leave-trees developed within a few weeks after spraying and became more pronounced throughout the fall of 1966, resulting in death of some trees (no damage was noted in unsprayed subplots). To assess the effects, damage surveys were made in August 1967 and September 1968. All trees on the sprayed subplots were examined and rated for herbicide effect by the following code:

0 = unaffected
1 = slightly affected
2 = serious foliage reduction and/or leader loss
3 = dead.

Heights of trees tagged and measured for the spacing study were remeasured in September 1970, four growing seasons following herbicide treatment.

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[2]Pfister, Robert D. and others. 1974. Forest habitat types of Montana. USDA For. Serv., Intermt. For. and Range Exp. Stn. and North. Reg., Missoula, Mont. Review draft, 213 p.

HERBICIDE EFFECTS

Tree Damage and Mortality

The herbicides damaged and killed trees on all sprayed subplots; however, no differences in the pattern of damage due to spacing and block effects were noted. The condition of lodgepole pine trees damaged by herbicides, 1 year and 2 years after spraying was as follows:

Damage Code - Description	*After 1 Year (Percent)*	*After 2 Years (Percent)*
0 - unaffected	41	45
1 - slightly affected	31	17
2 - seriously affected	21	22
3 - dead	7	16

One year after spraying, mortality averaged 7 percent on the sprayed subplots; and 52 percent were damaged by the herbicides. Nearly half of the damaged trees were seriously affected. Damage after 2 years showed a similar pattern--the most notable difference being an increase in mortality to double that of a year earlier. The increased mortality was due to death of trees that had been seriously affected the previous year. About 75 percent of the trees that had been only slightly affected in the first survey were seriously affected the following year, while the other 25 percent recovered. Examination of the study 3 years after herbicide treatment revealed no further mortality and no further deterioration in tree condition; therefore, damage was no longer recorded.

Four growing seasons after herbicide treatment, average 6-year height increment (adjusted for heights before treatment) was significantly less (0.01 level) on sprayed subplots than on unsprayed subplots. In fact, herbicide treatment was the only statistically significant source of variation in height growth at the time of remeasurement. The 6-year height increment (in 1970) was as follows:

Spacing (Feet)	*Sprayed (Feet)*	*Unsprayed (Feet)*
6 by 6	2.6	4.4
9 by 9	3.6	4.5
12 by 12	3.3	4.4
15 by 15	3.6	4.4
18 by 18	3.0	3.5

Effect on Understory Vegetation

All understory vegetation appeared to be killed by the herbicides, when examinations were made the summer following spraying. By the second year after spraying, however, the sprayed areas were rather uniformly occupied by cheatgrass (*Bromus tectorum* L.), an aggressive invader. Four years after spraying, lupine was becoming reestablished on the sprayed areas.

DISCUSSION AND CONCLUSIONS

The combination and amounts of herbicides used in this study (dalapon, 5 lbs ai; 2,4-D, 4.5 lb ae; and 2,4,5-T, 4.5 lb ae; per 100 gallons of water) seriously reduced the growth and survival of young lodgepole pines. Although all of the herbicides are considered selective in that they have demonstrated greater toxicity to grasses (dalapon) and broad-leaved species (2,4-D and 2,4,5-T) than to conifers, the effect of the particular combination used was not well understood--at least for lodgepole pine.

Greater susceptibility to 2,4-D than 2,4,5-T has been shown for ponderosa pine and sugar pine (Gratkowski 1961; Schubert 1962). Earlier, in an attempt to kill excess trees, young lodgepole pines in Alberta were killed by 2,4-D in diesel oil (Crossley 1950); in this case, the diesel oil probably increased the effect of the herbicide by acting as a cuticular solvent (Gratkowski, H., personal communication). Because the chemicals were combined in this study, it can only be speculated as to whether the trees were affected more by one herbicide than the other, or whether a synergistic effect was created by combining herbicides.

The season of application is important in silvicultural use of phenoxy herbicides, such as 2,4-D and 2,4,5-T; generally the pines are more sensitive to these herbicides than are Douglas-fir and the spruces (Arend 1955; Walker 1967; Gratkowski 1975). Among the pines, differences in seasonal susceptibility to phenoxy herbicide have been found for ponderosa pine and sugar pine (Gratkowski 1970); jack pine and red pine (Walker 1967); and jack pine versus red pine, eastern white pine, and Scotch pine (Arend 1955). In the latter two cases, jack pine (an interbreeding species with lodgepole pine) exhibited susceptibility to 2,4-D and 2,4,5-T in Michigan and Manitoba when sprayed after August 1, while the other pines were relatively unaffected.

Although the amount of 2,4-D and 2,4,5-T applied per acre in this study seems about twice the rate observed elsewhere, the amount the trees actually received is not known. Also, the possibility that this combination of herbicides at the rates applied can express its effect through the soil cannot be discounted. Whatever the reason for damage, it is clear that the amounts of herbicides used were excessive for young lodgepole pines.

The apparent effects of the herbicides on the trees lasted about 2 to 3 years. Mortality essentially ceased beyond this period, and a recovery of affected trees was noted in the third year following herbicide treatment. The herbicide effect on height growth appears to be temporary; the apical meristems and terminal leaders are affected for a year or two, causing loss of leaders and disruption of normal meristem development in the upper whorl. Nonetheless, these effects should not be casually dismissed. Growth research on many species has affirmed the fact that height growth reduction or loss, whatever the cause, cannot be recovered.

Factors requiring careful consideration in using herbicides in silviculture include: (1) insuring that herbicides are registered for use by the Environmental Protection Agency and approved for use on forest lands in the respective state; (2) selecting the silviculturally proper herbicide(s) and correct season(s) for application; (3) determining the minimum number of appropriate herbicides that will accomplish objectives, thus minimizing possible synergistic effects on trees; and (4) use of minimum amounts of herbicide to achieve the degree of control needed.

For this study, it is concluded that (1) combined amounts of phenoxy herbicides (2,4-D and 2,4,5-T) were excessive, not only for the health of the trees, but also for the vegetation control desired; and (2) the phenoxy herbicides were applied before summer growth had ceased. To be on the safe side, phenoxy herbicides for understory vegetation control in young lodgepole pine stands should not be applied until at least the first week in September or until all summer growth has definitely ceased (Gratkowski 1975).

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PESTICIDE PRECAUTIONARY STATEMENT

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

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